Damping with SMARTsense (Item No.: P1003069)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Mechanik	Schwingungen und Wellen	Dämpfung

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- Drawing cardboard (DIN A4)
- Tablet with measureApp

Experiment Variations:

Keywords:

Damping, Oscillation, Spring pendulum

Information for teachers

Introduction

Application

Oscillations occur in countless everyday applications. Whether it's swinging on the playground, playing a musical instrument or generating clocks with electronic devices. Vibrations can be wanted (e.g. oscillating quartz in watches) or unwanted (e.g. vibrations when driving a car).

Experimental set-up

Educational objective

The students have experimented several times with oscillating systems in previous experiments. There they discussed the variables that determine the duration of oscillation. Here, on the other hand, they should observe the oscillation amplitudes over longer periods of time and learn to know and measure their decrease over time. This leads to the concept of damping, which is to be introduced here, however, only qualitatively and not as the usually used logarithmic damping decrement. Also, the *e* function is not to be discussed here, although the measurement results are obtained in this form. However, a first introduction to this seems to make sense.

Task

1. Let a spring pendulum oscillate freely in air and measure the amplitude after different times. Compare the amplitude with the original amplitude. Then attach a disc to the spring pendulum and repeat the measurement.
2. Submerge the mass of the pendulum in water and investigate the deflection after different times.

Prior knowledge

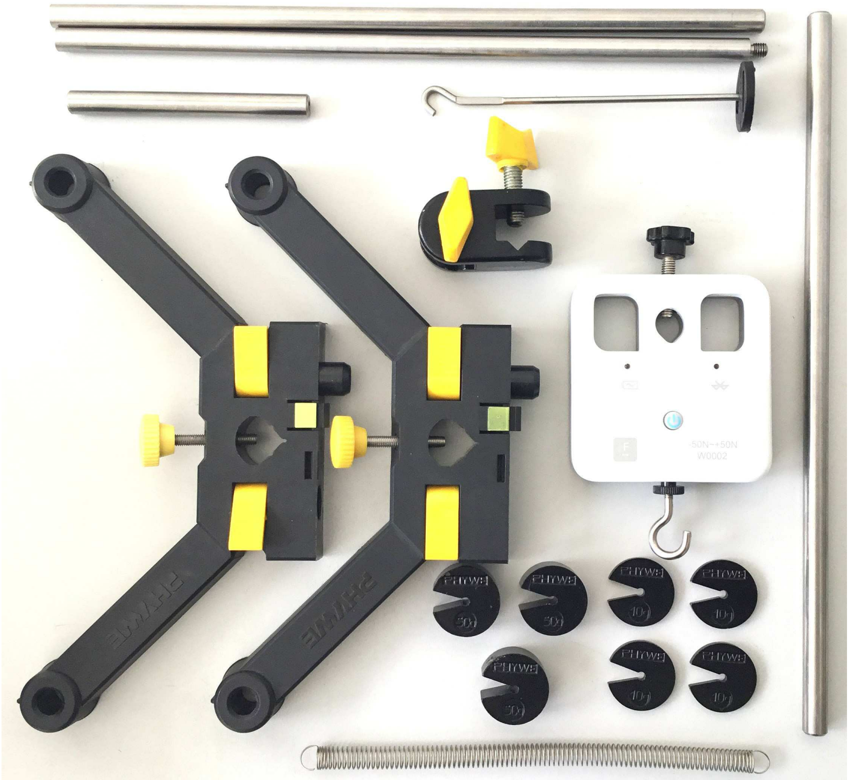
Students should be familiar with the terms vibration, period duration, frequency and amplitude.

Principle

Damping plays a role for every form of vibration. Depending on the situation, this is strong or weak.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
3	Boss head	02043-00	1
4	Helical spring, 20 N/m	02222-00	1
5	Weight holder	02204-00	1
6	Slotted weight, black, 10 g	02205-01	4
7	Slotted weight, black, 50 g	02206-01	3
8	Beaker, 250 ml, low form, plastic	36013-01	1
9	Support rod with hole, stainless steel, 10 cm	02036-01	1
10	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
11	Cobra SMARTsense - Force, ± 50 N	12904-00	1
Additionally required:			
	Drawing cardboard (approx. DIN A4)		
	Tablet with measureApp		



Safety informations

For this experiment, the general instructions for safe experimentation in science teaching apply.

Introduction

Application and task

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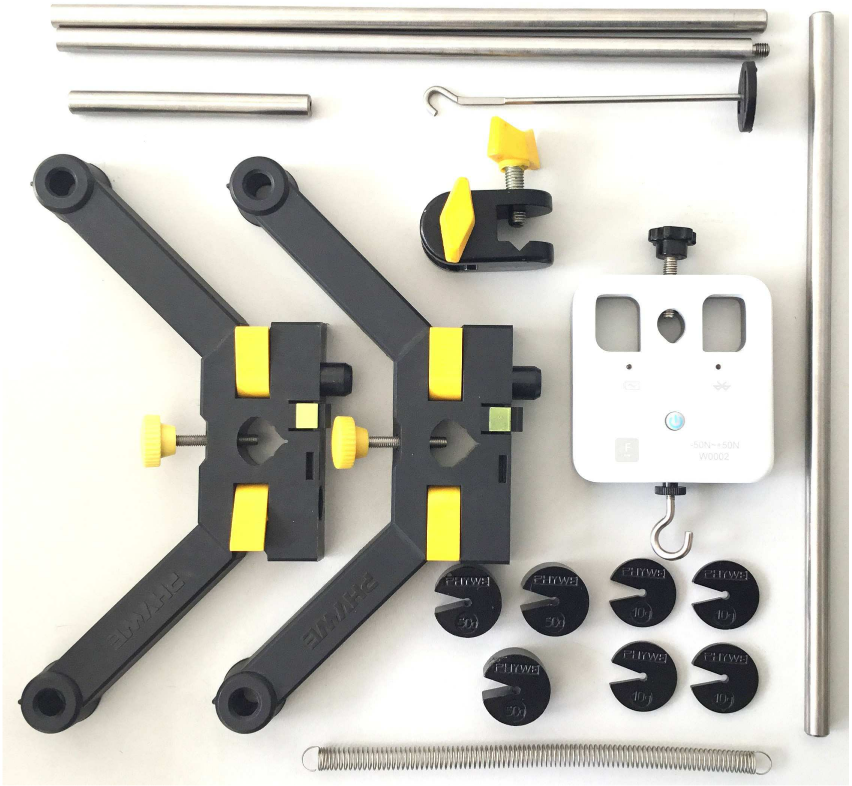

Set-up and procedure

Set-up

Turn the two-part stand rod together (Fig. 1). Assemble the tripod foot and rod as shown in Figure 2.

Fig. 1

Fig. 2

Attach the force sensor in the double socket (Fig. 3) and hang the coil spring on it (Fig. 4).

Fig. 3

Fig. 4

Procedure

- Switch on the force sensor by pressing the power button for several seconds. After successfully switching on, you will see a flashing LED (fig. 5).

Fig. 5

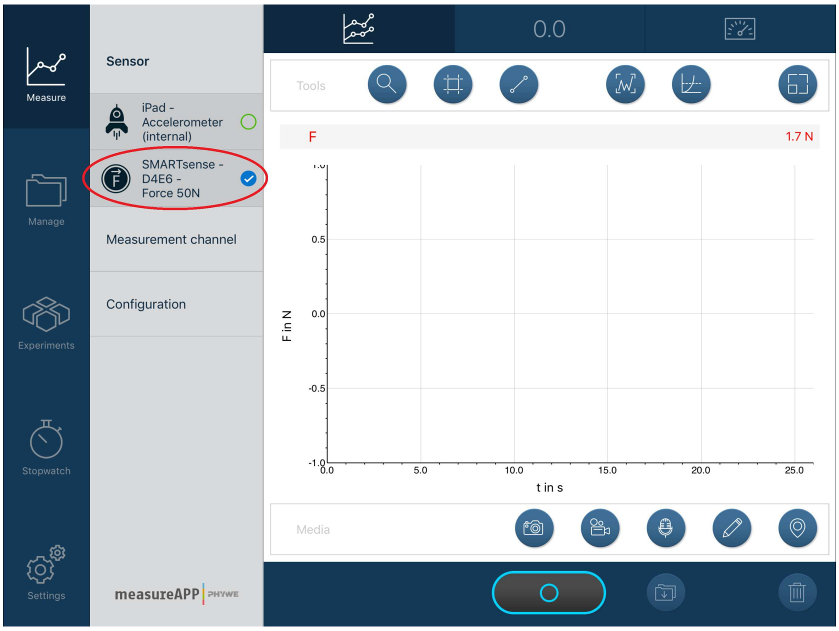

Fig. 6

- Start measureApp. Tap on the "Sensor" tab and select the force sensor (Fig. 6).
- Tap on the "Configuration" tab and select "Set to zero" (Fig. 8). Tap on the force sensor in the following window. Exit the window by clicking on save (Fig. 9).
- Hang the weight holder with a mass of 150g on the eye of the helical spring.
- The spring should be completely at rest and should not oscillate. Calm the system down with your hand.

Note: To attach the slotted weight to the weight holder, slide it over the upper end of the weight holder(Fig. 7).

Fig. 7

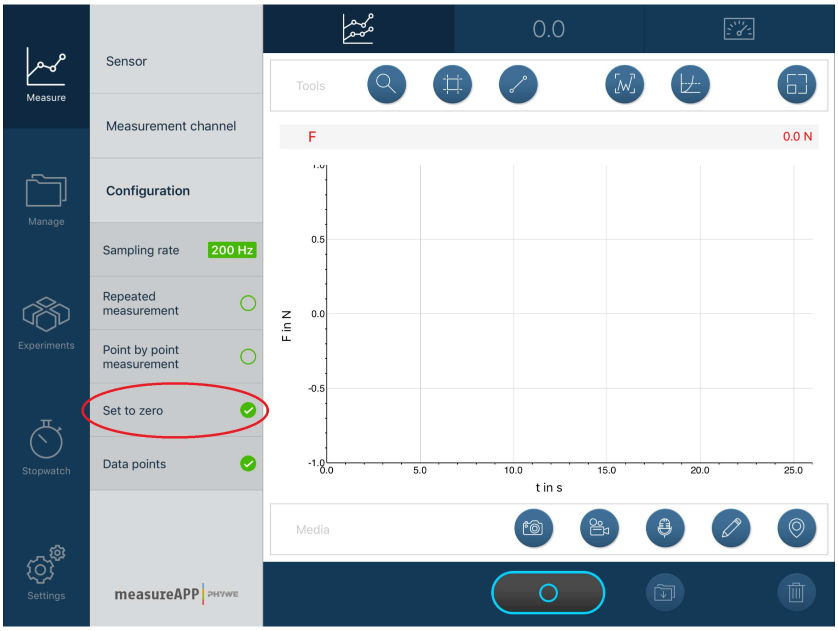

Fig. 8

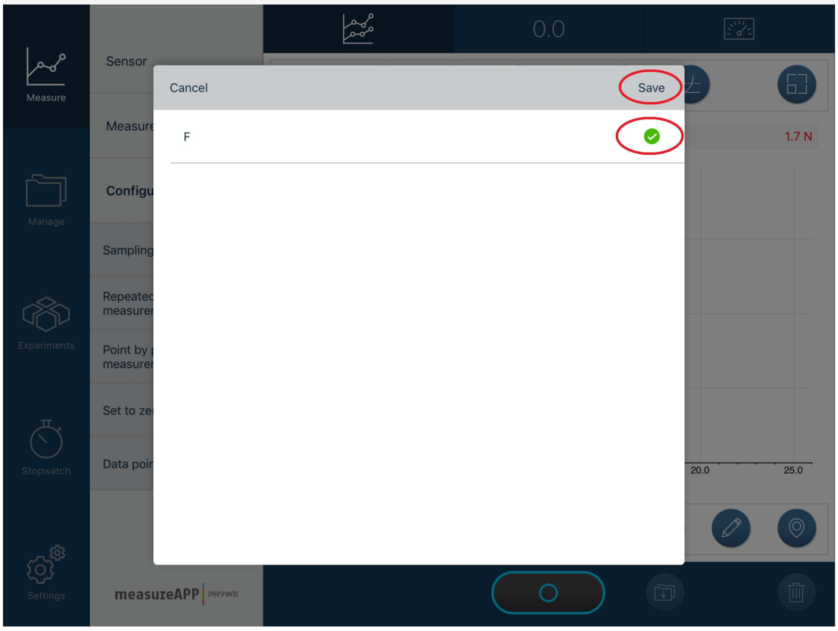

Fig. 9

- Make the mass oscillate. Make sure that the spring is only deflected vertically and does not make any lateral movements. Ensure this by observing the oscillation for a few seconds. If the vibration is not uniform, stop the spring and try again.
- Start the measurement (Fig. 10).
- Finish the measurement after three minutes (180 seconds).
- Use the auto-zoom function (fig. 10).
- Determine the mean value of the curve and write it down (Fig. 10).
- Read the maximum deflection of the force at the beginning of the measurement and note it (Fig. 11). To do this, zoom into the upper left corner of the graph with your fingers.
- Use the auto-zoom function again. Read off the maximum deflection at the end of the measurement and note it (Fig. 11). To do this, zoom into the upper right corner of the curve with your fingers.
- Save the measurement (Fig. 10).

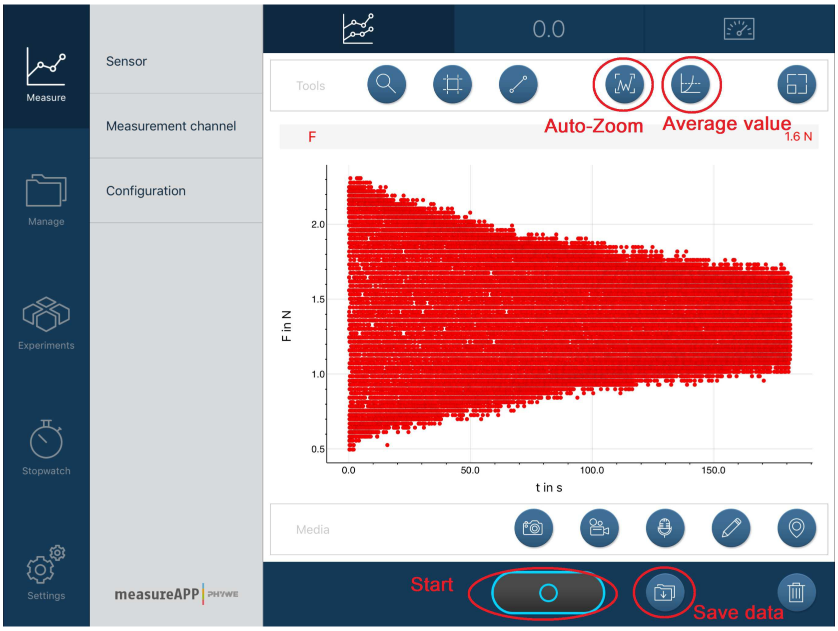

Fig. 10

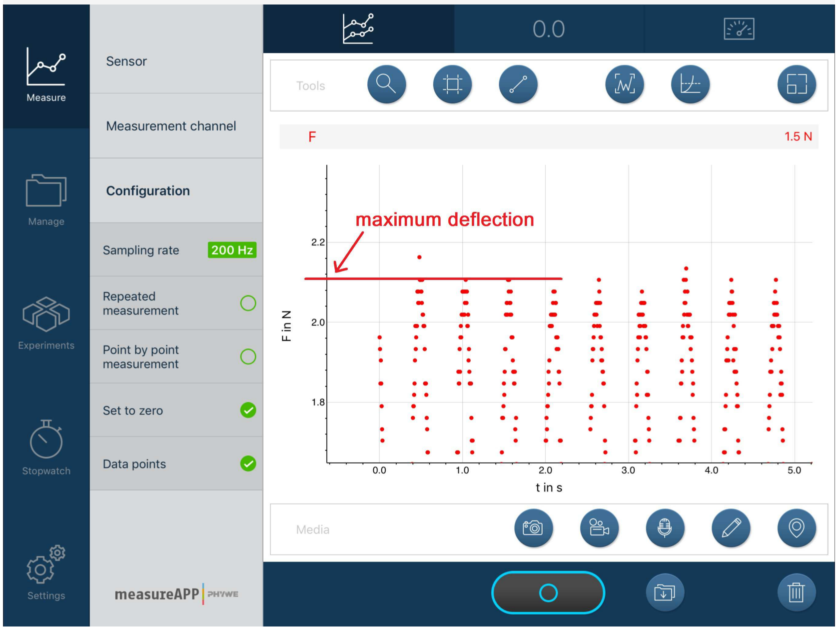

Fig. 11

- Mount a circular cardboard disc in the middle of the weight holder and repeat the entire measurement.
- Place the cup filled with water below the spring pendulum and immerse the weight holder so that the weight is centered below the water surface.
- Deflect the spring pendulum downwards from the equilibrium position until the weight reaches the bottom of the vessel. Then release the mass and simultaneously start the measurement for 10 seconds.
- Finish the measurement and proceed as described above.

Note: If you disassemble the tripod base, press the yellow buttons (Fig. 12).

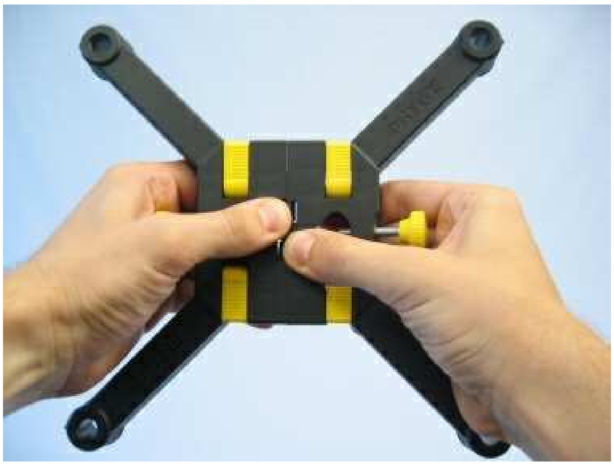

Fig. 12

Protkoll: Dämpfung mit SMARTsense

Auswertung - Frage 1

Gib für den Fall der freien Schwingung die ermittelten Werte an:

Mittlere Kraft	
Kraft bei maximaler Auslenkung (Anfang)	
Kraft bei maximaler Auslenkung (Ende)	

Auswertung - Frage 2

Überlege dir, wie du aus dem Mittelwert der Kraft die Masse des Federpendels bestimmen kannst und gib den berechneten Wert an.

Auswertung - Frage 3

Wie kann man aus den Tabellenwerten in Frage 1 die geometrische Auslenkung des Federpendels am Anfang und am Ende bestimmen? Gib eine Erklärung und berechne die Werte.

Auswertung - Frage 4

Um wieviel Prozent ist die Amplitude der Schwingung zwischen Anfang und Ende gesunken?

Auswertung - Frage 5

Gib für den Schwingungsfall mit Pappscheibe die ermittelten Werte an.

Mittlere Kraft	
Kraft bei maximaler Auslenkung (Anfang)	
Kraft bei minimaler Auslenkung (Ende)	

Auswertung - Frage 6

Berechne analog zu vorher die geometrischen Auslenkungen des Federpendels am Anfang und am Ende des Messung. Gib an, um wieviel Prozent die Amplitude gesunken ist und vergleiche mit dem vorherigen Ergebnis. Was fällt auf?

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Auswertung - Frage 7

Gib für den Schwingungsfall unter Wasser die ermittelten Werte an.

Mittlere Kraft	
Kraft bei maximaler Auslenkung (Anfang)	
Kraft bei minimaler Auslenkung (Ende)	

Auswertung - Frage 8

Berechne analog zu vorher die geometrischen Auslenkungen des Federpendels am Anfang und am Ende des Messung. Gib an, um wieviel Prozent die Amplitude gesunken ist und vergleiche mit dem vorherigen Ergebnis. Was fällt auf?

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Auswertung - Frage 9

Was bedeutet der Grenzwert 0 für die Amplitude der Schwingung?

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